DEVELOPMENT OF SUITABLE FUNCTIONAL CLOTHING FOR WORKERS OF CEMENT INDUSTRY

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SECTION -I

INTRODUCTION

Industrialization and modernization is a continuous process for growth and development of any country. India has a lot of potential for development in the construction and infrastructure sector. Thus, the demand of cement is no wonder increasing every year in India. Cement industry in India has also made great progress in terms of technological growth and modern industrialization. According to the report of the Working Group on Cement Industry for XII Five Year Plan (2012 – 2017), today India is the second largest producer of cement after China and is producing 6.7% of the world's output. The average annual growth of China and India is 11.4% and 9.8% respectively.

Cement industry is an integral part of Indian economy, providing employment and livelihood to more than a million people in direct or indirect form. At present, the cement production capacity of India is 390 million tons (MT), which is expected to reach 550 Million Ton by 2020 **(www.6).** It was found that, the demand of cement in India is mostly by the housing and infrastructure sector. The major consumption of cement for construction is done by housing sector, accounting 67% of the total consumption. Whereas, infrastructure consumes 13% while commercial and industrial constructions consume 11% and 9% respectively.

According to **Shah K.R. and Tiwari R.R (2010),** with the increasing demand of Portland cement in India, it's adverse effect on health of workers working in cement manufacturing and construction sector has become a burning issue. In addition to cement manufacturing industry workers, many construction workers belonging to organized and unorganized sectors are also exposed to cement dust and slurry for a long period of time which ultimately effects their health. A large numbers of work forces are engaged in construction of building, repairing, wrecking buildings, bridges, dams, roads, railway and so on. This work may include mixing, pouring, spreading concrete, asphalt, gravel

and other materials. Despite the increasing mechanization of construction and the more frequent use of pre-cast concrete sections, contact with wet cement still occurs, particularly in small jobs. Beside this, these workers often work in difficult conditions, including hot, cold and wet weather.

Thousands of workers associated with cement industry are exposed to cement and concrete every day without knowing its harmful effect on their health. Portland cement or concrete is a generic term used to describe a variety of building materials valued for their strong adhesive properties when mixed with water. It is a chemical which is highly alkaline in nature **(www.3)**. As per **Occupational Health and Safety Assessment Series (OHSAS)** when the skin of worker, comes in regular contact of this wet concrete, it may get affected and may result in *dermatitis*. Signs and symptoms of dermatitis include itching, redness, swelling, blisters, scaling and other changes in the normal conditions of skin **(www.2).** These skin related diseases can be prevented if the workers are provided with suitable protective work wear. In India, workers are still not provided proper personal protective work wear while working in cement related work. Keeping the safety of cement workers in mind, this area has been selected and would be further explored.

Due to the government's push for large infrastructure and investment projects **(Union Budget 16-17 by Govt. of India budget 2016)** India has become one of the largest cement manufacturer and user. Today the Indian cement industry is at its peak, producing best quality cement and supplying it worldwide.

The government of India is planning for 100 smart cities which may lead to an increased investment in infrastructure to USD 1 trillion in the 12^{th} Five Year Plan (2012 – 17) compared with USD 514 billion under the 11^{th} Five Year Plan (2007 – 12). The government is also planning to expand the capacity of the railway. The facilities for handling and storage of cement in order to ease its

transportation and reducing the transportation cost are also being considered. Thus, the production capacity of cement is expected to reach 407 Metric Tons by financial year 2017-18.

As per the press release by "Times of India", the Indian Transport Minister Mr. Nitin Gadkari **(1 Jan 2015)** launched new government plans and scheme for the betterment and advancement of Indian cement sector. It is stated that *the new roads which will be constructed will be of concrete.* The Mumbai – Goa Highway (NH – 17) will be converted into a four lane concrete road soon. With these upcoming plans, it is understood that the measures taken by government would lead to increase in construction activities and therefore boost cement demand in India.

SECTION -II

2.1 SIGNIFICANCE OF THE STUDY

In the cement industry the threat of respiratory problems and skin disease is a daily concern. While technological advancement have greatly decreased the direct exposure to dust and wet cement, still threat to skin disease is very real. Workers within the cement manufacturing industry and those using cement need to wear clothing that is resistant to dust.

Nose mask, gloves and helmets are engineered to protect them from various hazards in this industry. However as far as clothing is concerned, in this area most of the work done is in the developed countries. In the developed countries, there are set laws and legislations available that are supported by requisite standard for workers safety.

In developing country like India, manufacturing sector is growing very fast with large amount of work force which is also increasing. Hence there is a need to provide suitable work-wear that can provide them safety from dry and wet cement.

The aim of the present study is thus to develop a cost effective work-wear for the Indian cement industry. The title of the study is **"Development of Suitable Functional Clothing for workers of Cement Industry".**

The specific objectives framed for the present study are given below.

OBJECTIVES OF THE STUDY:

- To determine the magnitude of occupational health hazards related to clothing among the workers working with cement.
- Analyze the suitability of present personnel protective workwear in this industry.
- To standardize fabric parameters for clothing of cement industry workers.
- To design functional clothing for workers of cement industry.
- To evaluate the effectiveness of the developed functional clothing.
- To disseminate the information to the stakeholders.

DELIMITATIONS OF THE STUDY:

- The proposed study will be conducted in Delhi, National Capital region (NCR), Uttar Pradesh, Rajasthan and Haryana.
- The sample included in the study will be limited to a sample of 100 cement users only.
- The study will be limited to the development of fabrics and then designing workwear using developed fabrics only.

SECTION -III

LITERATURE REVIEW

It's true that domestic and international demand for cement has been increasing at a very fast pace in India. But it cannot be neglected that cement sector has caused adverse impact on environment and human health. As per **Sana S., Bhat G.A. and Balkhi H.M (2013),** generally cement plants are known to be associated with exposure to quartz, cement, dust and fly ash, which can potentially contribute many health problems and diseases. The impact of these things on health of worker of cement industry is countless. To understand the potential hazards which a worker comes across working in cement industry, review of literature was collected. Which includes studies and researches related to this area.

Several researchers have demonstrated the adverse effects of cement on the human health in their studies and have stressed that, cement which can be in dry stage, wet or in the form of dust is very dangerous for human health. According to the research done by **Kosmatka S. H et al (2008)**, chemical composition of cement is the main cause of health hazard among cement porters. During the manufacturing process of Portland cement, calcium combines with different raw materials to form four primary components of cement. These components are Tricalcium silicate ($3CaO.SiO_2$), Dicalcium silicate ($2CaO.SiO_2$), Tricalcium aluminate ($3CaO.Al_2O_3$) and Tetracalcium aluminoferrite ($4CaO.\ Al_2O_3Fe_2O_3$). Together they form Calcium sulfate (90% of cement mass) with gypsum (4% to 6%), which is the most dominant chemical present in cement. Cement workers in India work in very hot and humid climate in dusty circumstances. When exposed to moisture, which is the key ingredient of pastes, these primary components make chemical bond with water. Thus, form new components like calcium hydroxide and calcium silicate hydrate that enhance the property of hardening of cement. **Li J., Yu M. and Yang Y (2010),** state that even when not exposed to

moisture, dry cement powder containing calcium oxide is very hygroscopic and can cause many desiccation injuries. Cement reacts with liquids, such as moisture or perspiration, which then result in formation of wet cement layer and causes an exothermic reaction. **Alam M. et al (2007)**.

According to **Peters W.J (1984),** wet cement is caustic, abrasive and absorbs moisture easily. It also contains traces of hexavalent chromium Cr (VI), a toxic substance harmful to skin. At this stage, the pH of cement is more than 12.9 and it has the ability to create third degree alkali burns within two hours of contact. As per **Flowers M.W (1978)**, exposure to the wet cement even for an hour can cause third degree burns. These burns are also called cement burns. Cement burns may result in blisters, dead skin, hardening of skin, or black/ red/ green skin **(www.5).** In severe cases, these burns may extend to the bones and may cause disfiguring scars or disability. It was observed that, in the initial stage the workers do not feel anything, because cement burns may not cause immediate pain or discomfort. By the time a worker becomes aware of a cement burn, much damage has already been done **(www.1). "**Dermatitis" is the most common problem among the cement workers. Skin inflammation, itching, redness, swelling, blisters, scaling and other changes in the normal condition of the skin are a few symptoms of dermatitis. The literature from **U.S. department of labour OSHA (2008)**, suggests that cement has constituents that produce both irritant contact dermatitis and corrosive effects (from alkaline ingredients such as lime). Cement has the capability of sensitization, leading to allergic contact dermatitis from ingredients such as chromium.

Many researchers have reported that inhalation of cement dust irritates the respiratory epithelium and adversely affects the ventilator function. **Baby S et al (2008)**, report that cement dust contains heavy metals such as cobalt, nickel, lead, chromium and other pollutants harmful for our environment, humans, animals and ecosystems. A study done by **Al-Neaimi Y.I. et al (2001),** on the cement worker in UAE, proved that a higher percentage of the workers exposed to cement workers reported prolonged cough (30%), phlegm (25%), wheeze (8%), dyspnoea (21%), bronchitis (13%), sinusitis

(27%), shortness of breath (8%) and bronchial asthma (6%). Experiments by **Maviejewska A et al, Yang C.Y. et al (1991) and Noor H. et al (2000),** have shown that exposure to cement in the form dust is directly linked with inflammatory and pathological changes in the nasal and pharyngeal epithelium. This leads to an increased prevalence of chronic respiratory symptoms and it also leads to a reduction in ventilator capacity. According to **Adak M.D. et al (2007),** people exposed to cement dust zone areas are badly affected by respiratory and gastrointestinal problems. Diseases like chest pain, eye problems are likely to originated due to cement dust. A relative risk ratio assessment indicates that workers exposed to cement are 7.5 to 22.5 times more prone to these types of diseases as compared to the unexposed workers **Yhdego M. (1992)**.

The majority of the cement workers in India work without any professional protective clothing or Personal Protective Equipment (PPE). According to **Li J. et al (2011),** many reputed cement manufacturing or construction units do facilitate their workers with protective equipments like gloves, boots and helmets. However, the available protective equipments do not satisfy the needs of protection, comfort and cost as well.

When it comes to a particular standards for protective work wear for cement porters, there has not been any standard for cement porters protective work wear yet. At present, the selection of cement porter's protective work wear is done in accordance with standards on general protective clothing (ISO 13688 – 1998, ASTM F 1790-1997, ASTM F 903a – 1999, GB/T 13661-1992 or GB 17956-2000), which is a standard for dust proof clothing. In the standard for dustproof clothing GB 17956-2000 demand of fabric structure is set. However, these rules only refer to the basic dustproof requirement; they are too simple to consider the need of cement industry and worker's comfort when they do their jobs **Li J. et al (2011).**

PREVENTION FROM CEMENT RELATED HEALTH PROBLEMS

It is worth to say that “prevention is better than cure”. Controlling hazards at its source is the best way to protect. Depending upon the working conditions and work related hazards, Occupational Safety & Health Administration (OSHA) recommended use of some practices to minimize the work hazards. To minimize the risk of skin related problem, direct contact with wet and dry cement should be avoided. As per OSHA the employers must provide cement porters with the right type of Personal Protective Equipments (PPE), Protective Work Wear, proper washing facilities, proper hazard communication, reliable training and good work practices.

Several Occupational safety & Health Administration standards require employers to take steps to protect employees from hazards associated with exposure to Portland cement **(Table- 1).**

According to an **International Standard OSHA of United States (www.4)**, employers are responsible for providing a safe and healthful workplace. OSHA's mission is to assure safe and healthful workplaces by setting and enforcing standards and by providing training, outreach, education and assistance. Employers must comply with all applicable OSHA standards. Employers must also comply with the General Duty Clause of the OSH Act, which requires employers to keep their workplace free of serious recognized hazards. An in-depth study of the same reveals that the standard explicitly defines the requirements on the types of personnel protective equipments essential for different type of industries.

Table: 1 OSHA Standards and Their Application for Cement Workers

OSHA regulation number (www.4)	**Application**
29 CFR 1926 Subpart E; 29 CFR 1910 Subpart I.	Protective equipment includes personal protective equipment for eyes, face, head, protective clothing, respiratory devices, protective shields and barriers. They shall be provided, used and maintained in proper sanitary and reliable conditions. Appropriate PPE shall be based on the type of related hazards, such as processes hazards, environment hazards, chemical hazards, radiological hazards, or mechanical irritants encountered in a manner capable of causing injury or impairment in the function of any part of the body through absorption, inhalation or physical contact. All the protective equipment shall be provided by the employer without any cost.
29 CFR 1926.51 and 29 CFR 1910.141	Construction employers must be provided washing facilities to workers/porters who are exposed to Portland cement. Available washing facilities must provide clean water, non-alkaline soap and clean towels. Such facilities must be readily available to the employees and shall be adequate for the number of employees exposed.

29 CFR 1926.59; 29 CFR 1910.1200, 29 CFR 1926.21.	As per Hazard Communication standard the manufacturers and importers of cement must provide Material Safety Data Sheets (MSDSs) for cement industry workers dealing with regular exposure to wet and dry cement. They must label the hazards of Portland cement. Employers must make these MSDSs and labels available to employee and porters. Hazard should be communicated. The safety training standards also require employers to provide training sessions to workers to provide basic knowledge of hazards related to Portland cement. This training must address: ▪ Hazards associated with exposure to chemicals present in Portland cement, like CaO and Cr (VI) content. ▪ Preventive measures, including proper use and care of PPE. ▪ Importance of proper hygiene and facilities, PPE and information including Material Safety Data Sheet.
29 CFR 1904	As per OSHA record keeping standards, the manufactures and employers must provide; workers proper information on how to report work-related injuries and illnesses. They must record cases of work-related injury and illness (including cement burns and cases of dermatitis) that result from work, restricted work or transfer to another job. Record related to the medical treatment beyond first aid should also be available.

29 CFR 1926.55; 29 CFR 1910.1000	According to OSHA permissible exposure limit (PEL), employers must limit airborne exposure to Portland cement to 15 milligrams per cubic meter (mg/m^3) of air for total dust and 5 mg/m^3 for respirable dust. Because the Cr (VI) content in Portland cement is low, it is anticipated that by meeting the permissible exposure limit (PEL) of 15 mg/m^3 for Portland cement, employers will also meet the Cr(VI) PEL and action level of 5 and 2.5 micrograms per cubic meter ($\mu g/m^3$) respectively.

As per guidelines given by OSHA, **U.S. Departement of Labour, 3151 (2004),** following are the recommended workwear used by cement porters:

Hand and Arm Protection

Providing appropriate gloves to cement porters for the protection against chemicals is a must. Manufacturing and selection of gloves should be based on operation and the compatibility of work to be done. Chemical resistance, thermal property and mechanical strength must be examined before use. In general, gloves are divided into 5 types: (i) Leather gloves, (ii) canvas or metal mesh gloves; (iii) Fabric or coated gloves; (iv) Chemical and liquid resistant gloves; (v) Insulating rubber gloves.

Chemical resistant gloves are mostly recommended for caustic materials such as Portland cement. These types of gloves are made with different kinds of materials such as butyl, neoprene, nitrile, fluorocarbon (viton) and other plastic materials. These materials are either blended or laminated for use. It is believed that thinner the glove, better the chemical resistance and thicker the glove, less will be the grip and more would be the negative impact.

- **Body Protection *(Protective clothing)***

Appropriate protective clothing are necessary to prevent prolongation and direct skin contact with Portland cement. Protective clothes are available in market in variety of materials. A few are given below.

- Rubber, rubberized fabrics, neoprene and plastics – these materials protect against harmful chemicals and other types of hazards.
- Paper fiber - Disposable suits made of these provide protection against dust and splashes.
- Treated wool and cotton - Such clothing provide protection against changing temperature, dust, abrasion and dust.

- **Head protection**

Protective helmets or hard hats should have following properties: (i) Resist penetration, (ii) Shock Absorbency, (iii) Water resistant, (iv) Slow burn and Clear instruction of use and replacement. As per the standards and regulations, hats or helmets have a hard outer shell with a shock lining with headband and strap that hold shell from 1 to ¼ inches away from the head.

In India we have IS 18001: 2007 as our national standard. This intends to assist the organizations to develop a systematic approach to management of Occupational Health and Safety in such a way as to protect their employees and others whose health and safety may be affected by the organizations' activities. This standard serves as a guideline for all industries to ensure the safety and good health of all workers and stake holders. However it does not explicitly define the types of Personal Protective Equipment (PPE) which are found in the international standards.

The proposed protective clothing for cement industry workers therefore is an additional requirement in the wide interest of the cement industry of India. Thus keeping the related personnel safe and healthy, which is an objective of every growing industry.

PROTECTIVE WORKWEAR & PPE

The cement workers must be provided with appropriate and protective functional clothing. They ought to have Personal Protective Equipment including gloves, goggles and face shields (eight – inch minimum) to prevent prolonged skin contact with Portland cement in any form (**OPCMIA**). Table 2 explains the basic property of protective clothing required for the cement workers.

Table 2. Basic Desired Properties of Fabric for Cement Worker's Protective Workwear

Principles	**Properties**	**Requirement of fabric/ workwear**	**Objectives**
Protection	Dustproof	Compact fabric	To prevent dust from permeating through the workwear
	Abrasion Resistance	Abrasion resistant fibers, Low friction fabric structure	To resist force and friction
Comfort	Movement/ Flexibility	Appropriate designing of work wear	Design should be convenient for all sort of activities
	Thermal and Moisture comfort	Right type of inner layer/body contact fabric layer and good moisture management property of fabric	To ensure the thermal and moisture balance in workwear

Requirement of Personal Protective Workwear for Cement Worker

- Personal Protective workwear used should be selected with great care. It should be safe in design, well constructed and reliable.
- It should take in account the economic as well as the ergonomic requirements of the workers.
- The fit and comfort level of Personal Protective workwear should be taken into consideration while selecting appropriate workwear.
- Personal Protective workwear worn together with PPE, must be compatible.

A summary of reviewed literature related to the present study is tabularized and presented in Table 3.

Table 3: Tabular Summary of literature review		Research Factors									Research Approach			
		Management Commitment			Health Hazards			Work Environment						
SR. No.	Authors	Polici	Procedur	Objecti	Gener	Respirato	Skin	Ambie	Work	Infrastructu	Descripti	Concept	Emperi	Explorato
1	Shah K R and Tiwari R R (2010)						✓							✓
2	Study by US department of Labour, OHSAS (2008)	✓	✓	✓					✓		✓			
3	Press release by TOI (2015)		✓							✓	✓			
4	Sana S, Bhatt G A and Balkhi H M (2013)				✓									
5	Kosmatka S H, Kerkhoff B and Panarese W (2008)		✓							✓				
6	Wang R, Liu Z, Li J and Fang D (2004)			✓		✓							✓	
7	Li J, Yu M and Yang Y (2010)									✓			✓	
8	Alam M, Moynagh M and Lawlor C (2007)		✓				✓	✓				✓		
9	Peters W J (1984)						✓						✓	
10	Flowers M W (1978)						✓				✓			
11	Report of OCPMIA		✓							✓	✓			
12	Baby S, Singh N A and Vivek K (2008)					✓		✓				✓		

Table 3: Tabular Summary of literature review		Research Factors									Research Approach			
		Management Commitment			Health Hazards			Work Environment						
SR. No.	Authors	Policies	Procedures	Objectives	General	Respiratory	Skin	Ambient	Work Zone	Infrastructure	Descriptive	Conceptual	Emperical	Exploratory
13	Al - Neaimi Y I and Gomes J (2001)					✓				✓	✓			
14	Maviejewska A and Cybula G (1991)		✓					✓			✓			
15	Wang C Y (1996)					✓								✓
16	Noor H (2000)					✓				✓			✓	
17	Adak M D (2007)							✓			✓			
18	Yhdego M (1992)						✓		✓			✓		
19	Li J, Yu M and Yang Y (2011)			✓						✓			✓	
20	Agarwal N and Jain N K (2014)			✓	✓				✓		✓			
21	US guidelines for using Portland cement (1978)		✓	✓	✓									
22	PPE study by US department of Labour (2004)													
23	XII five year plan (2012 - 2017) by Ministry of Commerce	✓	✓	✓	✓				✓					

Section - IV

METHODOLOGY

Cement workers often work in outdoors and indoors. They are exposed to very dusty environment due to fly of cement dust. They have to work in very hot or cold conditions when working outdoors. The present study is an attempt to develop suitable workwear for cement workers. A conceptual frame work for the study and the research design is given below.

Research Design:

The present study is an experimental study and would be carried out in three phases. To identify the magnitude of occupational health hazards, field survey will be conducted. The complete conceptual framework is given briefly in figure 4.1

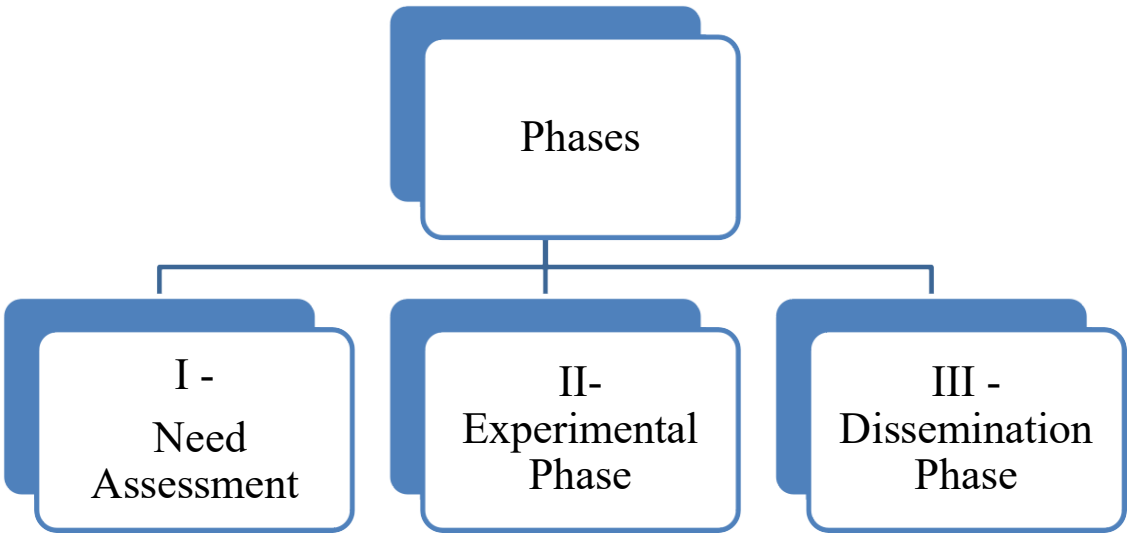
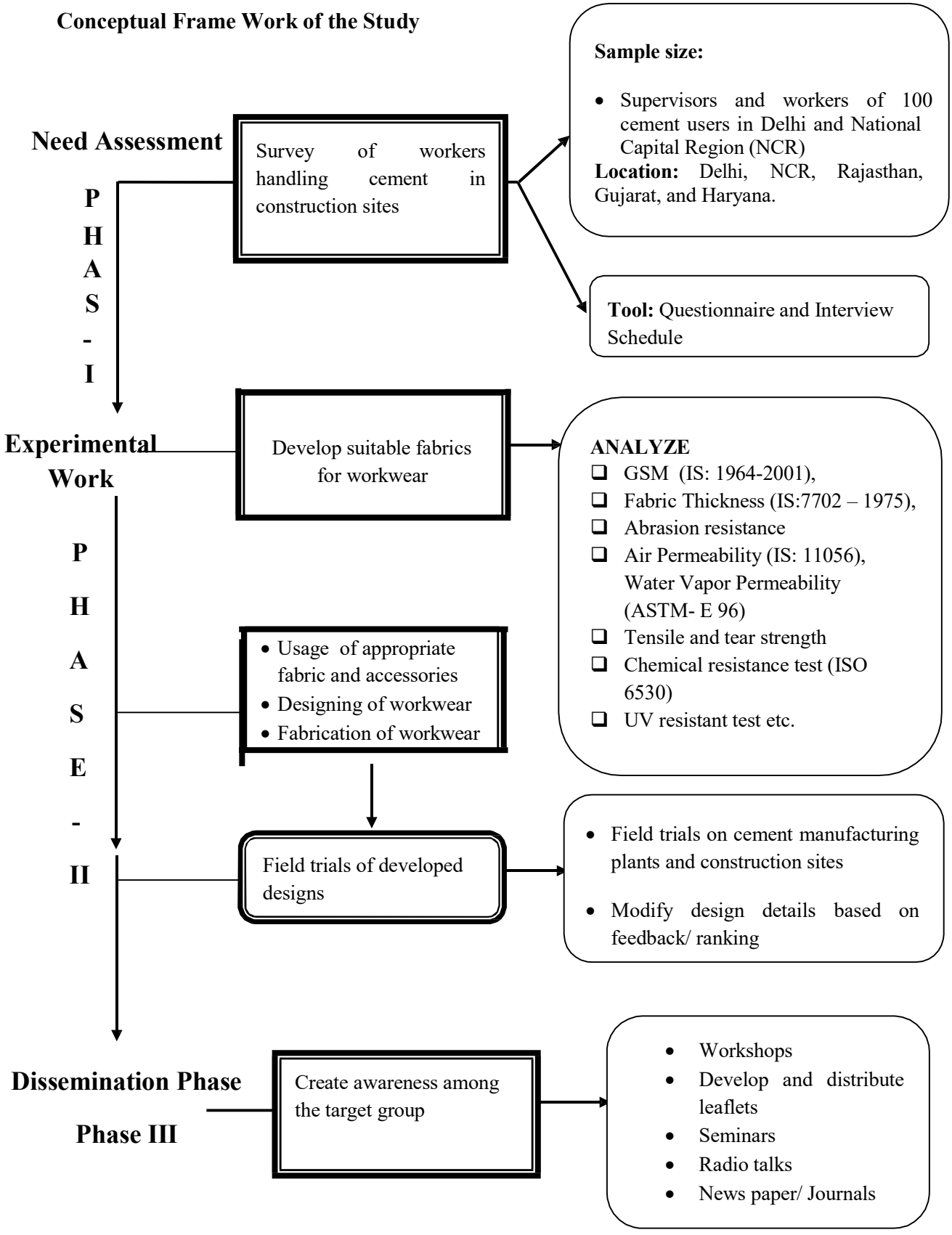


Figure: Phases included in the study

Conceptual Frame Work of the Study


Need Assessment
PHASE-I
Survey of workers handling cement in construction sites
Sample size:
Supervisors and workers of 100 cement users in Delhi and National Capital Region (NCR)
Location: Delhi, NCR, Rajasthan, Gujarat, and Haryana.
Tool: Questionnaire and Interview Schedule
Experimental Work
PHASE-II
Develop suitable fabrics for workwear
ANALYZE
GSM (IS: 1964-2001),
Fabric Thickness (IS:7702 – 1975),
Abrasion resistance
Air Permeability (IS: 11056),
Water Vapor Permeability (ASTM- E 96)
Tensile and tear strength
Chemical resistance test (ISO 6530)
UV resistant test etc.
Usage of appropriate fabric and accessories
Designing of workwear
Fabrication of workwear
Field trials of developed designs
Field trials on cement manufacturing plants and construction sites
Modify design details based on feedback/ ranking
Dissemination Phase
Phase III
Create awareness among the target group
Workshops
Develop and distribute leaflets
Seminars
Radio talks
News paper/ Journals

Phase I-

Need Assessment:

To determine the magnitude of occupational health hazards related to clothing among the cement workers, field study will be conducted. In order to understand the need of the clothing and the magnitude of hazards faced by the group, a field survey in real situation in this area would be done.

To begin with, a few construction sites will be visited to understand the working conditions in Indian scenario. There after a self designed questionnaire for the target samples would be used to collect data. The questionnaire would include important aspects like working conditions, health of workers, working hour, duration of work, type of existing work wear and other protective equipments being made available. The questionnaire will be filled either by literate people themselves or an interview with the ground staff would be planned individually using self a designed interview schedule.

Besides this, two different questionnaires would also be designed. One questionnaire for top/ middle level management personnel and the other for lower level management personnel.

After the survey, data obtained shall be analyzed to understand the need of the users and accordingly the development of suitable work wear will be obtained.

Selection of area: The present study will be conduct on construction sites in areas of Delhi, National Capital Region (NCR), Uttar Pradesh, Rajasthan, and Haryana for collecting data. In the NCR area sites will be randomly selected for the present study.

Sample size: The sample would include workers from 100 cement users in Delhi, NCR, Uttar Pradesh, Rajasthan, and Haryana states for data collection.

Tools for collection of data: Self designed questionnaire and interview schedule will be used as a tool for the collection of data. The literature review will help in designing questionnaire. The tool will be used to measure the factors that effect health, working conditions and existing workwear of cement workers. Appropriate Statistical tools will be used for the analysis of the collected data.

Phase II-

Experimental work:

- **Development of appropriate fabric:** The fabric for workwear will be developed as per the requirement of the cement workers. In this study various types of fabric materials- single or multi layers will be developed keeping in mind the need of cement workers.

- After development of the fabric, it would be evaluated for GSM, thickness, air or water vapor permeability, abrasion resistance, chemical resistance, strength loss due to UV exposure and dust resistance. On the basis of the test results, safety, comfort and durability of developed fabric will be evaluated. The results achieved on these quality parameters then would guide the final selection of appropriate fabric for workwear for the workers exposed to cement.

- **Designing of appropriate workwear and selection of accessories for cement industry workers:** Designing of workwear is a very important aspect for workers working in cement related industry. If the design of workwear is not proper then even the most appropriate developed fabric and selected accessories will not give any result. Therefore during designing utmost care would be taken. Another important point to consider during designing workwear would be the easy donning (putting on) and doffing (taking off) of the developed work wear. Under this various designs of work wear will be developed keeping in mind the above obtained information, movement and working conditions of the workers in Indian climate. In the present study at least five designs would be developed. A field trial for each design will thereafter be done on the prototype and on the basis of ranking; the most appropriate design will be selected. The designing will take into consideration the functional, aesthetic and structural elements of the workwear. The comfort provided would be emphasized in view of its usability.

- **Evaluate the effectiveness of the developed workwear through field trials:** In the present study, design verification would be a very essential part. Under this, the design of the work wear will be assessed and modified after taking various field trials. For field trials, at least twenty workwear of selected design would be developed and distributed to the workers working in the cement related industry for usages and assessment. The trials would be accompanied by a feedback form which would be self designed and would consist of questions related to functionality, comfort and performance ability of the developed design as workwear for cement workers. To conduct the field trials written permission from the Ethics Committee will be taken, as it would involve interaction with researcher and the subject.

Phase III-

- **Dissemination of information - Awareness campaign:** The developed workwear will have no relevance if it does not reach the users. In order to disseminate the information of the developed workwear following strategies would be used.
    - **Workshops –** A few workshops will be organized for lower management and workers working in construction sector to create awareness on functional characteristics and limitation about the developed workwear. For this related sites like cement manufactures, cement traders and other interested parties shall be contacted.
    - **Leaflets-** To promote the product effectively, brochures or leaflets shall be developed with all information of the product on it. The brochure or leaflet would then be distributed to at least more than a thousand users. The distribution shall be done in hard form to worker as well as in soft form to the interested parties at managerial levels. For better understanding of the product, the brochures or leaflet shall be developed in the local language for the users to understand. It would be developed in Hindi (for workers and lower management) and in English (for top and middle management).
    - **Seminars-** A few seminar shall be organized for top and middle management personnel of cement users with an objective to make them aware of the developed product. To make these seminars effective it shall be ensured that the selected sample and others involved with cement industry are invited. At least two such seminars shall be organized at two different locations for this purpose.

- **Radio Talks**- Radio stations shall be contacted and radio talks designed for creating awareness for larger audience through talk show. In order to maximize audience interest these radio talks would be aired entirely or almost entirely in local language.

- **Print Media-** articles related to availability, limitation, usage, coasting etc. of developed workwear would be provided to society through newspaper/ journals.

Statistical analysis- for the statistical analysis, following techniques will be used in the present study to analyze the collected data.

- Arithmetic Mean
- Mode
- Median
- Percentage
- T-test

Section - IV

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